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ABSTRACT

The identification of the characteristics of teaching experts can help beginning teachers to learn and provide a picture for both beginning science teachers and science educators on what has been accomplished and what has to be done in the future. This study, as part of an evaluation project, was intended to investigate the progress of a group of beginning chemistry teachers on teaching techniques that had been taught in a preservice training program. Fifteen beginning chemistry teachers were observed and videotaped in the classroom. The teachers had graduated from one of the three universities which provide the preservice training of chemistry teachers in Taiwan. The results reveal that the beginning chemistry teachers were able to improve significantly in the teaching techniques of asking divergent questions and giving appropriate wait time to students after questioning. However, almost no progress was made on the following teaching techniques: (1) using analogies to explain theoretical concepts; and (2) initiating classroom discussions. The quantitative results of the study indicate that a typical beginning science teacher tends to ask students to memorize science content knowledge and formulas. Contains 14 references. (LZ)

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The Development of Beginning Chemistry Teachers' Teaching Techniques

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The Development of Beginning Chemistry Teachers' Teaching Techniques

Introduction

In recent years, attempts have been made to distinguish the differences between experts and novices (e.g., Engle & Bukstel, 1978; Larkin, McDermott, Simon & Simon, 1980; Patel, Frederiksen &Groen, 1984). The field of teaching is no exemption. Berliner (1986) indicated that novices were not as good at recognizing patterns as experts; Carter, Sabers, Cushing, Pinnegar, and Berliner (1987) found that novice teachers and expert teachers processed and used information differently; Martin and Reynolds (1993) concluded that the view of an experienced mathematics teacher toward a learning environment focused on the overall pattern of activity within a classroom, while a rookie mathematics teacher tended to look from individual to individual. The identification of the characteristics of teaching experts can help beginning teachers to learn just like pointing out the way for a child to look at a constellation. On the other hand, the evaluation of beginning science teachers' progress can provide a picture for both beginning science teachers and science educators on what has been accomplished and what has to be done in the future.

It is believed that the first few years of teaching is particularly difficult for beginning science teachers (Marso & Pigge, 1987). For example, Brickhouse and Bodner (1992) have documented the constraints of a typical science teacher. However, from another point of view, practical teaching experiences would create some positive gains for beginning science teachers. Consequently, what outcomes and changes would occur? This study, as part of an evaluation project, was intended to investigate the progress of a group of beginning chemistry teachers on teaching techniques that had been taught in a preservice training program.

Purpose of the Study

The purpose of the study was to answer the following questions: (1) What techniques show significant progress by beginning chemistry teachers? (2) What teaching techniques need to be improved for beginning chemistry teachers? (3) Do beginning chemistry teachers' teaching perform better at the end of the first year than at the beginning of the first year? Hopefully, the results of this study may also serve as a feedback for science teacher training institutions.

Methodology

Sample

Fifteen beginning chemistry teachers who were teaching in fifteen different junior high schools participated in this study. The beginning chemistry teachers graduated from one of the three universities which provide the preservice training of chemistry teachers in Taiwan. All the teachers were in their first year of teaching using the same physical science textbook.

Procedure

This study employed classroom observations and videotaped recordings to collect data. Each of the fifteen teachers was observed and videotaped for 100 minutes of classroom teaching which consisted of 50 minutes of observation at the beginning of

the school year (pretest) and the other 50 minutes at the end of the school year (posttest). The participants were told that their teaching performance would be evaluated before conducting the observations, but they were not told the specific criteria upon which they would be assessed. Each recorded episode was transcribed and analyzed to yield data for analysis. The data analysis focused on the following topics: (1) Frequency of asking convergent questions (e.g., What gas is produced from the burning of a candle?) (2) Frequency of asking divergent questions (e.g., How do you show the existence of CO_2 in a soft drink?) (3) Frequency of using analogies to clarify science concepts (e.g., The particles of a mole were likened to grains of sand or rice.) (4) Frequency of initiating classroom discussions either between students and the teacher or within students. (5) General teaching performance including 8 evaluation items which were shown in Table 1. The 3-point Likert scale was used in the evaluation of the teaching performance: 0=never happens, 1=happens occasionally, 2=always happens. Items 2, 6, and 7 in Table 1 were reverse scored so that a high score indicates a good teaching performance.

Table 1 Items of Teaching Performance Evaluation

1. Teacher continually assesses class understanding and adjusts pace accordingly (pace)
2. Teacher attempts to quickly cover a pre-determined amount of material (rushing)
3. Teacher encourages students to answer questions (encouraging)
4. Classroom atmosphere is comfortable with appropriate teacher-student interactions (interactions)
5. Students are actively involved in learning (involving)
6. Teacher asks students to memorize the science facts and formulas in textbook (rote memory)
7. Students always wait for next activity (down time)
8. Teacher gives at least 3 seconds after asking a question to students (wait time)

Data Analysis

In order to promote the consistency of data analysis, the videotapes were transcribed and repeatedly reviewed by both the author and a graduate assistant. Each 50-minute videotape was randomly assigned in a numerical order, the graduate assistant did not know if a videotape were pretest or posttest. The author and the graduate assistant did the data analysis separately based on the items of the evaluation sheet which includes Table I's items and those topics mentioned before. The final scores were based on the average of the two researchers' ratings. When any item's frequency count or a Likert scale was different by 2 or more, the videotape was reviewed together by the two researchers and another science educator until a consensus was reached.

The Wilcoxon sign rank test was conducted to check the frequency differences between the pre and post-tests. For the purpose of comparing the beginning teachers' pre and post general teaching performance, dependent t-tests were used to test the significance of the differences.

Results

It can be seen from Table 2 that the beginning chemistry teachers made significant progress on the frequency of asking divergent questions in their classroom teaching($p<0.01$). The median frequency of using this technique in the pretest was 0.5 while the posttest median was 4. Though the frequency of asking convergent

questions in the posttest was not significantly higher than the performance in the pretest, from the max, medium, ant minimum values, we can see that not only did more teachers use the teaching technique, but they used the technique more frequently in the second semester (posttest). Among the four techniques listed in Table 2, using analogies and initiating classroom discussions seem to be two of the most difficult techniques for the beginning chemistry teachers to implement, especially the technique of initiating classroom discussions (The medians of both the pre- and post-test were 0). It reveals that at least half of the beginning teachers did not use this teaching technique either the pre- or post-test.

Table 2 Frequency Medians for the Use of Teaching Techniques

	pretest	posttest	P*
1. Using analogies to explain theoretical concepts	0 (max=2, min=0)	1 (max=7, min=0)	0.375
2. Asking convergent questions	5.5 (max=12, min=0)	8 (max=17, min=0)	0.105
3. Asking divergent questions	0.5 (max=4, min=0)	4 (max=9, min=0)	0.008
4. Initiating classroom discussions	0 (max=2, min=0)	0 (max=7, min=0)	--

*: P value of the Wilcoxon sign ra. k test.

Table 3 presents the pre-and post test differences of the beginning teachers' general teaching performance that were listed in Table 1. Looking at the mean differences, it is apparent that these beginning chemistry teachers did better in the post test on 6 out of the 8 items of performance, especially on the item #8 (After asking a question, the teacher gave at least 3-second of wait time to let students developing answers.($t=4.84$, $p<0.001$). Though the t values for the other 5 items of teaching performance were not significant , the post test means were higher than the pre test means(i.e., mean differences were >0). The only item with a negative mean difference was item #6(Teacher asks students to memorize science knowledge and formulas in textbook). It seems that the beginning chemistry teachers emphasized the importance of memorizing the science knowledge and formulas more in the second semester than in the first semester. When the 8 items of teaching performance were added up , the highest possible total of general teaching performance would be 16. Based on the result of the dependent t-test, the post test mean of the total was significantly higher than the pretest mean of the total at the $p=0.05$ level.

Table 3 t-test results of the pre- and post-teaching performance.

	Difference#	SD	t value
1. pace	0.25	0.18	1.39
2. rushing	0.17	0.11	1.48
3. encouraging	0.08	0.23	0.36
4. interactions	0.25	0.13	1.91
5. involving	0.33	0.19	1.77
6. rote memory	0.17	0.21	-0.80
7. down time	0	0.17	0
8. wait time	1.17	0.24	4.84***
9. total	2.08	0.79	2.63*

#: the difference between the posttest and pretest means
*: $P<0.05$
***:$P<0.001$

Discussion

The results of this study reveal that beginning chemistry teachers have improved significantly in the teaching techniques of asking divergent questions and giving appropriate wait time to students after questioning. However, almost no progress was made on the following teaching techniques by the beginning chemistry teachers : (1)using analogies to explain theoretical concepts,(2)Initiating classroom discussions. The use of wait time in science teaching has strongly recommended by Rowe(1983;1987) to increase the quality of student answers to questions, meanwhile, asking divergent questions is desirable in science classes to develop students' critical thinking and creative behaviors.(Trowbridge & Bybee ,1986). This study found that these two teaching techniques were easily adapted by beginning chemistry teachers. On the other hand , using analogies and initiating classroom discussions were rarely accommodated in the beginning chemistry teachers' science teaching, though the efficacy and benefit of these two teaching techniques have been reported in many studies(Brown, 1992; Harrison,1993; Wong, 1993). Further research can investigate the barriers preventing the beginning chemistry teachers from conducting these teaching techniques. If they have difficulties in developing these skills, the science teaching methods class should provide more strategies and practice in the preservice training.

The results of this study reveal that the beginning chemistry teachers tended to emphasize the importance of memorizing science knowledge and formulas in the second semester. This tendency deserves a special note from science educators. This finding is also consistent with the result of Brickhouse and Bodner's case study(1992), in which the beginning teacher asked students to memorize the science content knowledge and formulas in order to pass examinations, though he was aware of that the students should be critical thinkers in science class. Both the quantitative results of this study and the qualitative findings of Brickhouse and Bodner(1992) indicate that a typical beginning science teacher tends to ask students to memorize science content knowledge and formulas. Further research can try to find out what is needed to help beginning science teachers act as learning facilitators instead of as knowledge givers.

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